# Warm summers, not human beings, control spruce bark beetles

*by Ed Berg*

After ten years of massive spruce bark beetle mortality, I am hearing fewer calls that we "do something" about the spruce bark beetles. Early on, the Forest Service was criticized for not stemming the beetle advance in Cooper Landing and Moose Pass. Slash left along the Bradley Lake powerline was blamed for starting the beetle outbreak in Kachemak Bay. Beetle-infested logs (from Ninilchik) piled on the Homer Spit were seen as beetle nurseries that would feed beetles into the city of Homer.

My basic take on all this is that we human beings had nothing to do with the bark beetle outbreak (apart from perhaps warming the global climate). We were caught in a rising tide, and "time and tide wait for no man," as they say. The rising tide is climate warming, starting in 1976 and intensifying in 1987. Beetles like warm summers and we had a string of remarkably warm summers from 1987 through 1997.

The accompanying graph compares several climate indicators with the annual "red-needle" forest acreages, from Forest Service aerial surveys. After the beetles kill a spruce tree, the needles turn red in the following spring and then start dropping off. Red-needle acreage figures thus represent fresh kill, not total kill over a period of years. It usually takes 2-3 years from the time that beetles enter a stand to generate red-needle trees. (Keep this 2-3 year lag in mind—its importance will be explained below.)

I see two distinct warming effects in the graph: drought stress and a "long warm summer" effect. The post-1987 warm summers have increased evapotranspiration: we have more evaporation from soil and water, and more breathing out of water by plants (transpiration). We see the results in dried ponds and falling lake levels around the Peninsula. This loss of water can produce drought stress in trees and make them more susceptible to all kinds of infestations and diseases, as well as to forest fires. Drought-stress is particularly severe in the spring when sunshine and warm air temperatures turn up photosynthesis in the leaves (needles). The leaf pores (stomates) open wide and breathe out water, but frozen soil prevents water uptake from the roots. Low water pressure in the tree reduces the trees' ability to pump pitch into the beetle borrows, which would immobilize the beetles. The beetles have evolved the timing of their mating flight to new trees at just this moment when the trees "have their pants down," i.e., usually late May or early June.

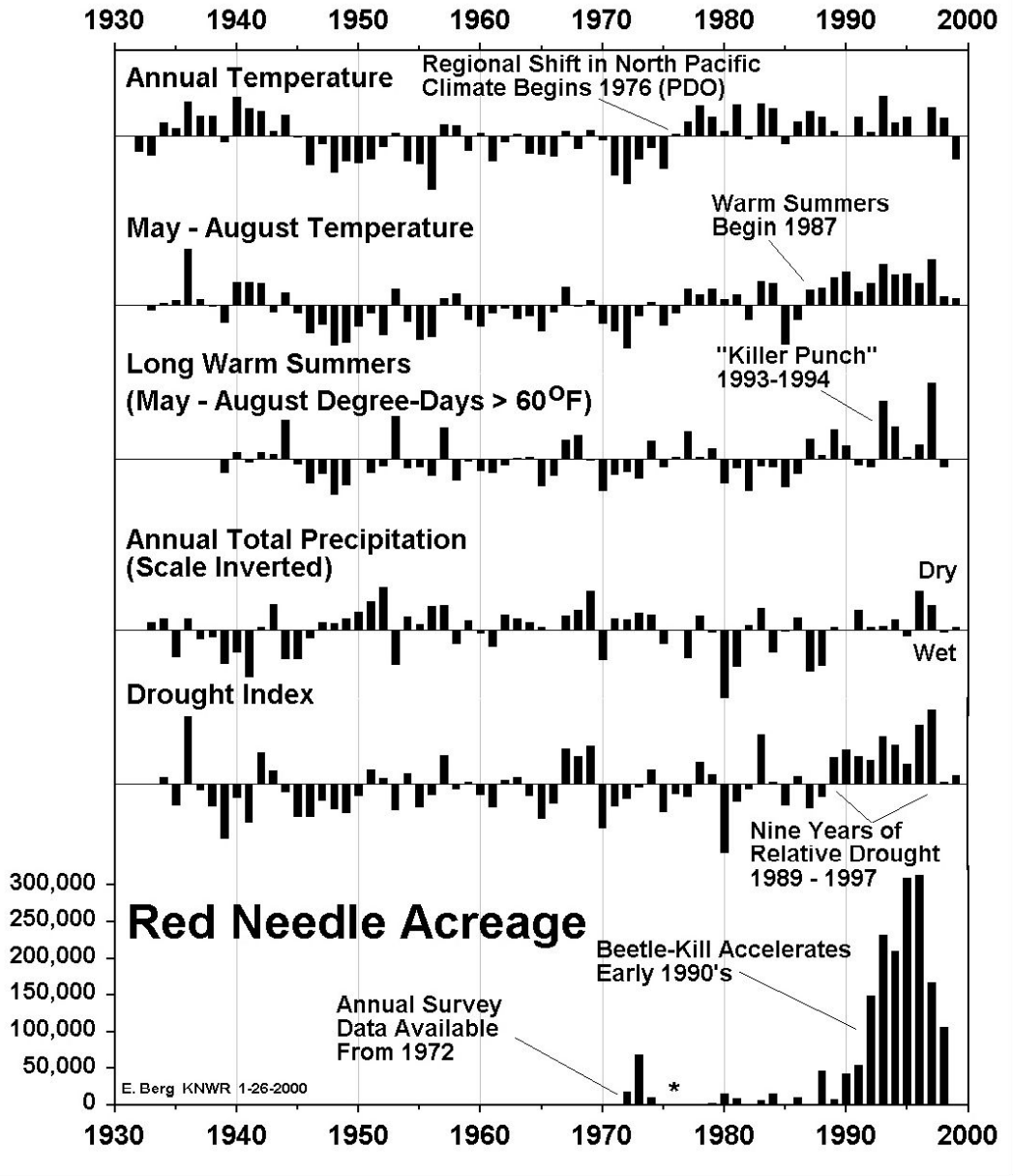
The Drought Index (based on May-Aug temperatures and Oct-Sept total precipitation) clearly shows an unprecedented run of drought years from 1989 through 1997. Red-needle acreages really take off in 1992, three years after the drought began. (Remember, it takes 2-3 years of beetle activity to turn the needles red.)

The "long warm summer" effect is more subtle, but it's the killer punch. Normally the bark beetles have a two-year life cycle: the eggs are deposited in the spring (after the mating flight) and they hatch into larvae (white grubs) in the summer. They overwinter as larvae, then become adults (pupate) during the next summer. They spend a second winter in the tree, and then make their mating flight to a new tree in the following spring (two years after hatching). This is the standard pattern, but in a long warm summer they can go all the way to adulthood by the first fall, and hence spend their first winter as adults rather than as larvae. This "accelerated graduation" produces slightly smaller beetles, so that in the next spring one sees two sizes of beetles flying. I saw this, for example, in the Fritz Creek area in 1998, following the record long warm summer of 1997. Releasing two generations of adults (one- and two-year beetles) simultaneously doubles the beetle population.

To measure the long warm summer effect, I calculated Degree-Days Above 60°F. These Degree-Days are the opposite of heating degree-days that are used for winter fuel oil calculations; they represent total summer warmth available for beetle growth and activity. I used 60°F as the benchmark because bark beetles need 60°F days in the spring before they can make their mating flight. On the graph we see alot of degree-days in 1993 and 1994. This two-year double-whammy, added on top of accumulating drought stress, was the

killer punch that brought the southern Kenai Peninsula spruce forests to the mat in 1995 and 1996 (with red-needles over 300,000 acres each year). Everything since 1996 has been mop-up. Red-needle acreages have declined dramatically since 1997 because there is not much mature spruce forest left to kill: the beetles have eaten themselves out of house and home.

Given the warm summers, I see nothing that we could have done to stop the overall outbreak. At low beetle densities, landowners can take defensive actions such as thinning, pruning lower branches, spraying carbaryl, and burning trap trees. But when the climate tide rises, as it did beginning in 1987, the rules all change, and the beetles take charge.




*Climate indicators (from the Homer airport) are standardized to show trends above and below the long-term averages. Red-needle acreages include drainages from Tustumena Lake to the Anchor River.*
*[*] Survey was not done in 1976.*

It is worth noting on the graph that we have just experienced two relatively cool and drought-free summers. It is possible that we have entered a relatively cool period, which could last 20 to 30 years, similar to that of the mid-1940's to 1975. A 20-30 year cycle in a 100 year record of North Pacific sea surface annual temperatures has recently been identified, and named the Pacific Decadal Oscillation (PDO). Kenai and Homer track this record rather closely (correlations of +76% and +80%, respectively). If this cycle is real, we are due for a cooling. I'll explore this in a future column, but interested readers can check out this research at http://www.atmos.washington.edu/~mantua/abst.PDO.html. If summers continue to cool, our remaining spruce trees may survive; so don't be too quick to cut your green trees on the expectation that they will all die sooner or later. The end of the outbreak may be in sight!

*Ed Berg has been the ecologist at the Kenai National Wildlife Refuge since 1993. He also teaches geology at the Kenai Peninsula College in Soldotna and Homer. Previous Refuge Notebook columns can be viewed on the Web at http://www.fws.gov/refuge/kenai/.*